

Anatomy Hand-out

THORAX



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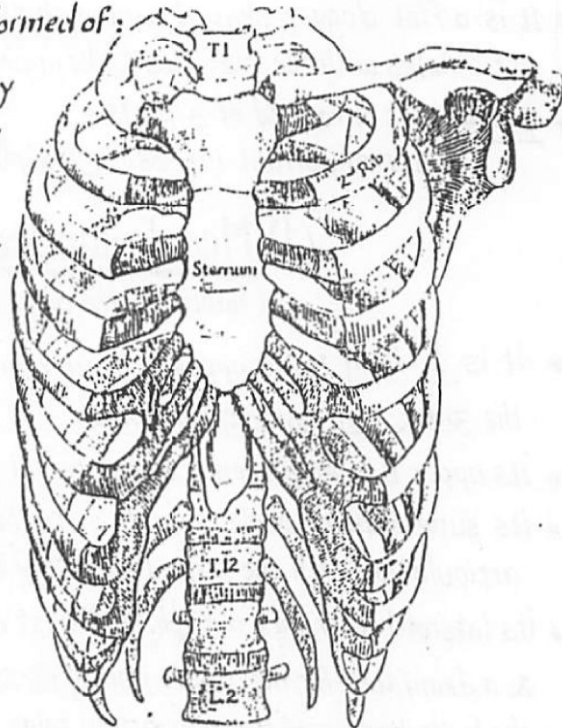
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The Thoracic cage

1

(A) Structure : the thoracic cage is formed of :

- (1) the vertebral column :-----posteriorly
- (2) the sternum :-----anteriorly
- (3) 12 pairs of ribs & their costal cartilages:-----on either side



(B) Functions :

(1) Supportive & protective function:

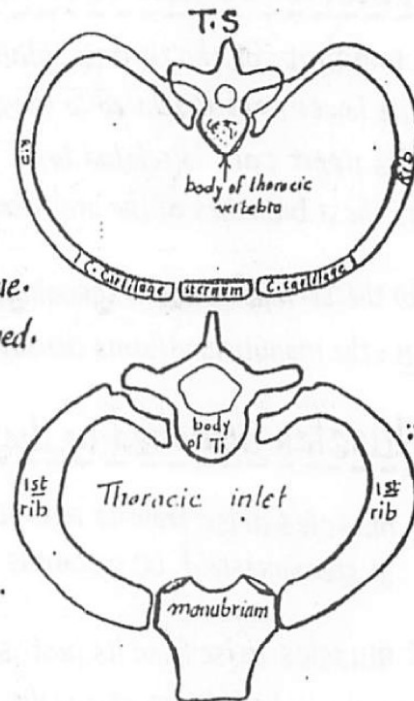
- (a) it supports & protects the thoracic viscera.
- (b) its lower part protects the upper abdominal viscera.

(2) Respiratory function:

the increase in the capacity of the thoracic cage (due to elevation of ribs & forward movement of the sternum) leads to decrease of the intra thoracic pressure & sucking of air into the lungs in inspiration.

(C) Shape of the thoracic cage :

- * it is conical in shape, being narrow above & wide below.
- * its antero-posterior diameter is much diminished due to the forward projection of the bodies of the vertebrae.
- * In transverse section, the thoracic cage is kidney-shaped.



(D) The thoracic inlet (superior aperture) :

- * it is the upper opening of the thoracic cage at its junction with the root of the neck.
- * Boundaries & structures passing through : see page 19.

(E) The thoracic outlet (inferior aperture) :

- * it is the lower opening of the thoracic cage at its junction with the abdomen.
- * Boundaries & structures passing through it : see page 20.

Bones of the thoracic cage 2

1- the Sernum

* It is a flat dagger-shaped bone which supports & articulates with the clavicles & the upper 7 pairs of ribs.

* parts : it is formed of 3 parts:

(1) manubrium (2) body (3) xiphoid process.

(1) Manubrium Sterni

(handle of the dagger)

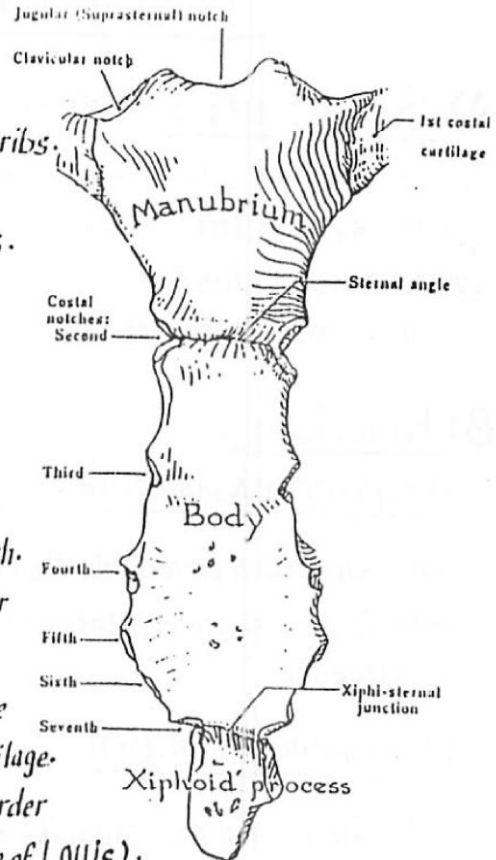
* it is 2" long & lies opposite 2 vertebrae :
the 3rd & 4th thoracic vertebrae.

* its upper border presents suprasternal (jugular) notch.

* its supero-lateral angle presents a clavicular notch for articulation with the sternal end of the clavicle.

* its lateral border has a notch for the 1st costal cartilage & a demifacet for the upper part of the 2nd costal cartilage.

* the lower border of the manubrium joins the upper border of the body of the sternum at the sternal angle (angle of Louis).



* Posterior relations of the manubrium:

(1) remnant of the thymus gland.

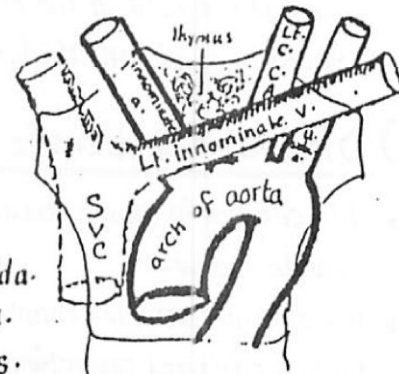
(2) its lower part is related to the arch of aorta.

(3) its upper part is related to:

(a) the 3 branches of the arch of aorta:

- innominate a.
- Lt. Common Carotid a.
- Lt. subclavian a.

(b) the Lt. innominate v. (crossing in front of these 3 arteries).



N.B: the manubrium forms the ant. boundary of the superior mediastinum

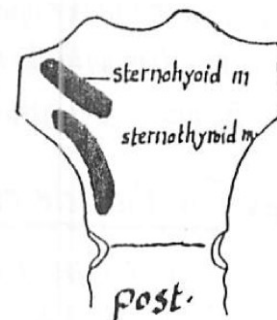
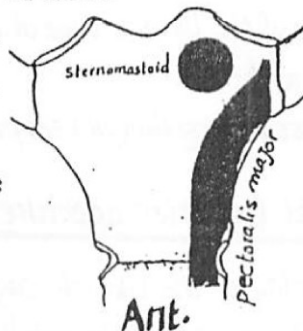
* Muscles attached to the manubrium:

- 2 muscles arise from its ant. surface:

(1) sternomastoid (2) pectoralis major.

- 2 muscles arise from its post. surface:

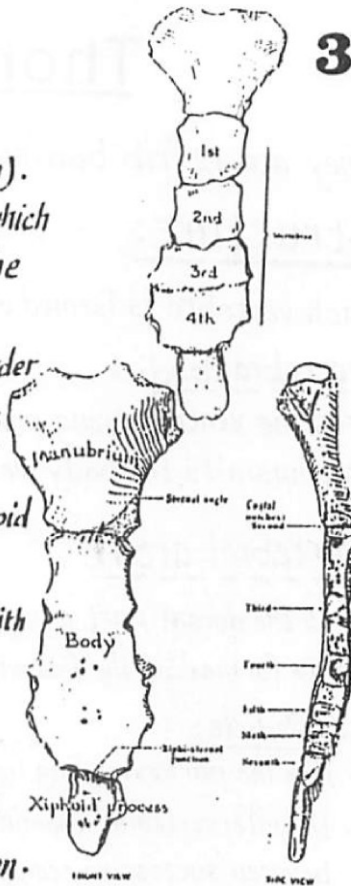
(1) sternohyoid (2) sternothyroid.



(2) Body of the Sternum

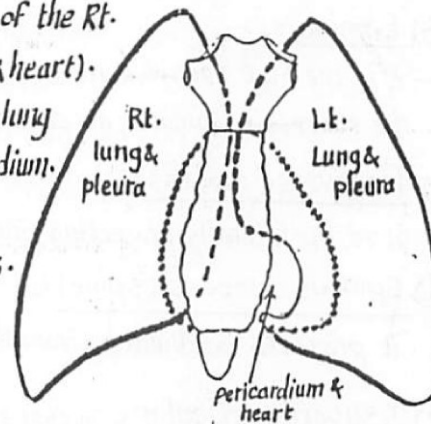
3

- * It is the longest part of the sternum (4" long)
- * it lies opposite $4\frac{1}{2}$ vertebrae (T5, 6, 7, 8 & upper $\frac{1}{2}$ of T9).
- * it is formed by the fusion of 4 parts called sternebrae which start fusion at puberty to form a single body at 25 years. The sites of fusion are indicated by 3 faint transverse ridges.
- * the upper border of the body articulates with the lower border of the manubrium by a 2^{ry} cartilagenous joint which forms a forward projection called the sternal angle.
- * its lower border articulates with the upper border of the xiphoid process (xiphisternal junction).
- * the lat. border of the body carries notches for articulation with the lower part of the 2nd costal cartilage & the 3rd, 4th, 5th, 6th & the upper part of the 7th costal cartilage.



* Posterior relations of the body of Sternum:

- the body forms the ant. boundary of the ant. mediastinum.
- its Rt. side is related posteriorly to the ant. borders of the Rt. lung & pleura (separating the sternum from pericardium & heart).
- its Lt. side is related above to the ant. borders of Lt. lung & pleura while below it is directly related to the pericardium.
- the whole post. surface is related to remnant of thymus gland & attached to it sup. & inf. sterno-pericardial ligaments.

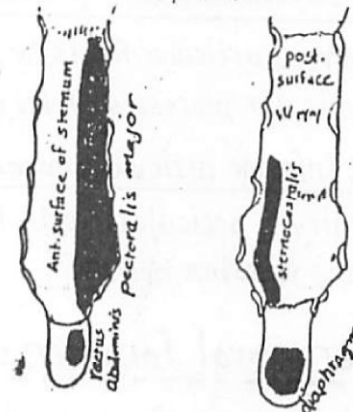


* Muscles attached to the body of Sternum:

- (1) pectoralis major m. : arises from its ant. surface.
- (2) Sternocostalis m. : " " " post. surface.

(3) The Xiphoid process

- * it is the small lower part of the sternum & usually remains cartilage till the age of 40 years.
- * it articulates with the body of the sternum & with the lower part of the 7th costal cartilage
- * it is related posteriorly to the liver & falciform lig.
- * its tip gives attachment to the linea alba.
- * its ant. surface gives insertion to rectus abdominis m.
- * its post. " " origin to the diaphragm.



* CLINICALLY IMPORTANT POINTS RELATED TO STERNUM : see page 97.

Thoracic vertebrae

4

* They are 12 "rib bearing vertebrae".

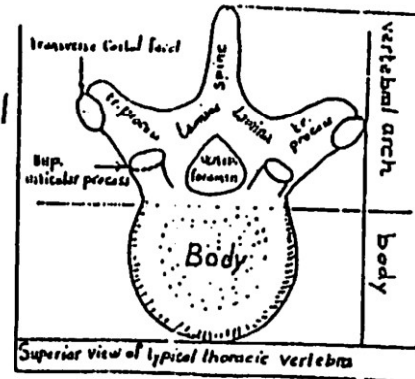
* Structure:

- each vertebra is formed of 2 main parts

1- Vertebral body:

- it is the ventral strong part of the vertebra.
- it transmits the body weight downwards.

vertebral arch
body



2- Vertebral arch:

- it is the dorsal part which surrounds the spinal cord.
- it is formed of the following parts:

(a) Pedicle:

- it is the part extending from the body to the transverse process.
- the intervertebral foramina (which give exit to the spinal nerves) lie between successive pedicles.

(b) Lamina:

- it is the flat part of bone extending from the transverse process to the spine.
- the successive laminae are connected by ligamenta flava.

(c) Transverse process:

it is the laterally projecting process at the junction between the pedicle & the lamina:

(d) Spinous process (Spine):

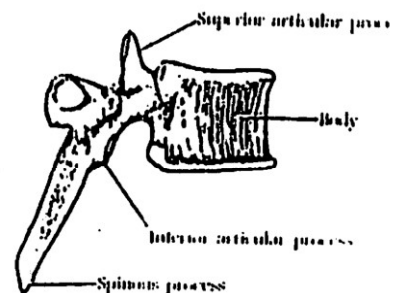
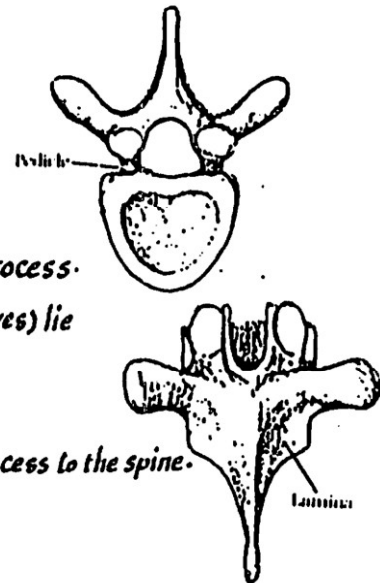
it projects backwards from the vertebral arch.

(e) 2 Superior articular processes:

Carry 2 articular facets for articulation with the inferior articular processes of the vertebra above.

(f) 2 Inferior articular processes:

Carry 2 articular facets for articulation with the sup. articular processes of the vertebra below.



(3) Vertebral foramen:

- lies between the vertebral body & the vertebral arch.
- the successive vertebral foramina form the vertebral canal which lodges the spinal cord.

How Vertebrae are connected together?

(1) Vertebral bodies : are connected together by:

(a) the intervertebral discs (2ry Cartilagenous joints).

(b) the ant-longitudinal lig. : connecting the ant-surfaces of the vertebral bodies.

(c) the post-longitudinal lig. : connecting the post-surfaces of the vertebral bodies.

(2) Laminae : are connected together by ligamenta Flava (contain yellow elastic fibres).

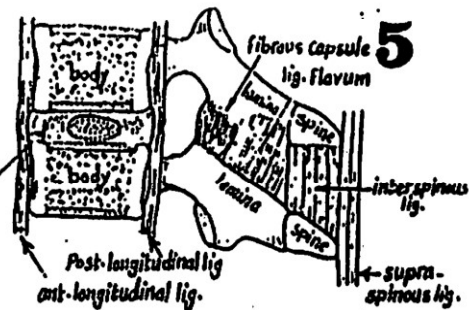
(3) transverse processes : are connected by intertransverse ligaments.

(4) the Spines : are connected by:

(a) interspinous ligaments : connecting the adjoining spines

(b) supraspinous ligament : Connecting the tips of spines (from C7 to sacrum).

(5) Articular processes of adjoining vertebrae are connected by the Fibrous Capsules of the intervertebral joints.



Classification of thoracic Vertebrae

(A) typical vertebrae
(from 2 - 8)

(B) non-typical vertebrae
(1st, 9th, 10th, 11th & 12th)

(A) Characters of the typical thoracic vertebrae:

(1) The body : is heart-shaped & has sup. & inferior demifacet for articulation with heads of ribs.

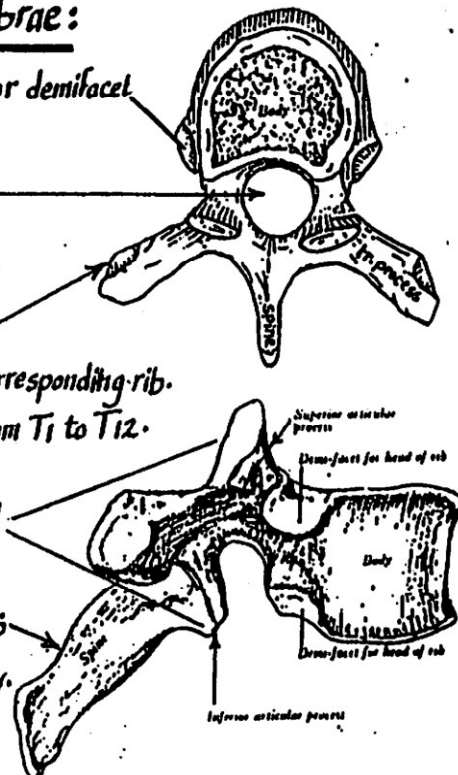
(2) The vertebral foramen is narrow & circular

(3) The transverse process : is directed posterolaterally and has an articular facet near its tip anteriorly for articulation with the tubercle of the numerically corresponding rib.

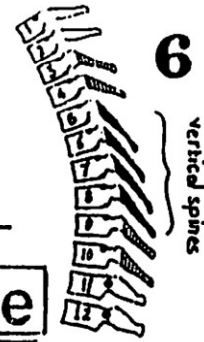
N.B. : the tr. processes become progressively shorter from T₁ to T₁₂.

(4) The sup. & inf. articular processes are nearly vertical

(5) The spinous process is long & directed downwards & backwards with varying degrees of obliquity.



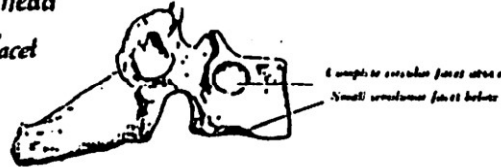
N.B : the spines of the middle 4 thoracic vertebrae (T5,6,7 & 8) are long & vertical but those above & below are progressively more horizontal.



Non-typical thoracic Vertebrae

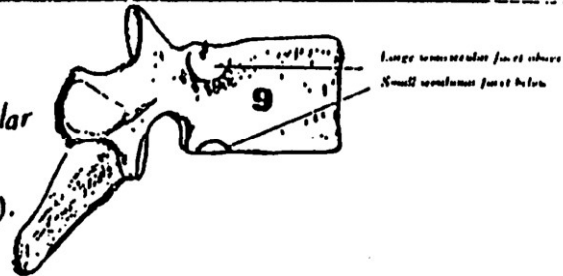
(1) The First (T1) :

- the body is small in size and kidney-shaped.
- It has one superior complete facet (for the head of the 1st rib) and small inferior semilunar facet (for part of the head of the 2nd rib).
- the vertebral foramen is triangular.
- the spine is long & nearly horizontal.
- the transverse process has a costal facet.



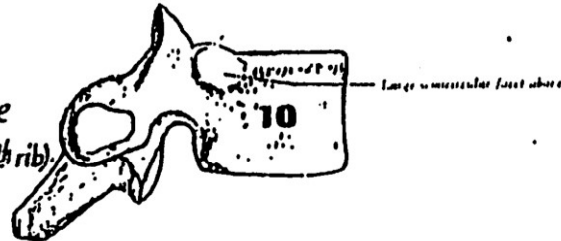
(2) The ninth (T9) :

- the body is large, has large sup. semicircular facet (for the head of the 9th rib) & a small inf. semilunar facet (for part of head of 10th rib).
- the transverse process has a costal facet.



(3) The tenth (T10) :

- the body is large & has only one large sup. semicircular facet (for the head of 10th rib).
- the transverse process has a small costal facet.



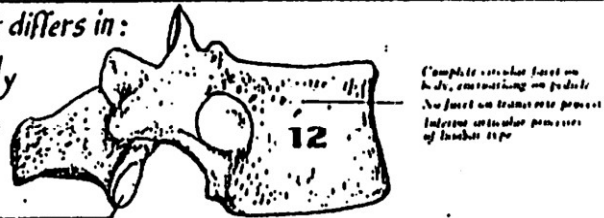
(4) The eleventh (T11) :

- the body is large & has only one complete circular facet above (for head of 11th rib).
- the transverse process is small & has no costal facet.



(5) The twelfth (T12) : like T11 but differs in :

- the complete circular facet on the body encroaches on the middle of the pedicle.
- the inf. articular facet is directed laterally instead of forwards.



* For detailed anatomy of the vertebral column see page 93.

Ribs (costae).

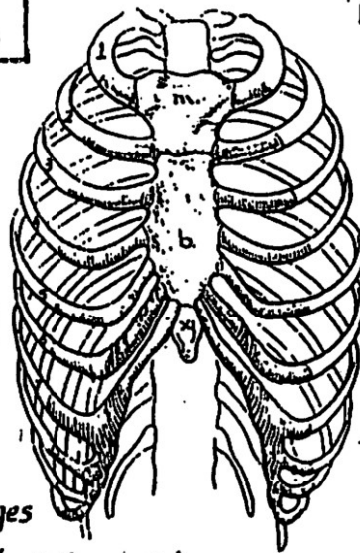
7

There are 12 pairs of ribs, all of them articulate posteriorly with the bodies of the thoracic vertebrae.

Classification of the ribs

I- Classification according to their relation to sternum:

- (1) True ribs: the upper 7 ribs whose Costal cartilages join the sternum directly (vertebro-sternal ribs).
- (2) False ribs: the 8th, 9th & 10th ribs whose Costal cartilages join each other & join the 7th Costal Cartilage forming the Costal margin.
- (3) Floating ribs: the 11th & 12th ribs who end freely in the abdominal muscles.



II- Classification according to their relation to the vertebral column:

- (1) Typical ribs: From 3 to 9:
the posterior end (head) of each of them articulates with 2 thoracic vertebrae & the intervertebral disc inbetween.
- (2) Non-typical ribs: 1, 2, 10, 11 & 12:
the head of each non-typical rib articulates with the vertebra of the same number with the exception of the 2nd rib which articulates with 2 vertebrae (T₁ & T₂).
N.B: the second rib is considered non-typical because its shaft differs from that of the typical ribs.

* General features about all ribs & Costal cartilages:

- (1) The level of the 2 ends of the ribs: the level of the posterior or vertebral end of each rib lies at a higher level than its anterior end.
- (2) The direction of the ribs & Costal cartilages: with the exception of the first 2 & the last 2 ribs, the ribs run downwards while their cartilages run upwards.
- (3) The length of the ribs: ribs & Costal Cartilages increase in length from the 1st rib to the 7th rib (the longest rib) then they decrease in length again.
- (4) The lateral projection: ribs increase in the lateral projection from the 1st rib to the 8th rib (the most laterally projecting one).
- (5) The obliquity of the ribs: ribs increase in obliquity from the 1st rib to the 9th rib (the most oblique one).

General features of the typical ribs 8

Each typical rib has 3 parts: ant-end, shaft & post-end.

(1) The anterior end:

is cup-shaped & articulates with the Costal cartilage

(2) The Shaft: is divided by the angle into:

(a) post. $\frac{1}{4}$ which is cylindrical &

(b) ant. $\frac{3}{4}$ which is flattened & has:

- 2 borders: an upper rounded border & a lower sharp border.

- 2 surfaces: an outer convex surface & an inner concave surface showing a costal groove in its lower part lodging the intercostal v., A. & N (from above downwards).

(3) The posterior end: formed of head, neck & tubercle

(a) the head: has 2 articular facets separated by a crest:

- the upper facet: articulates with the lower demifacet of the body of the vertebra above.

- the lower facet: articulates with the upper demifacet of the body of vertebra of the same number.

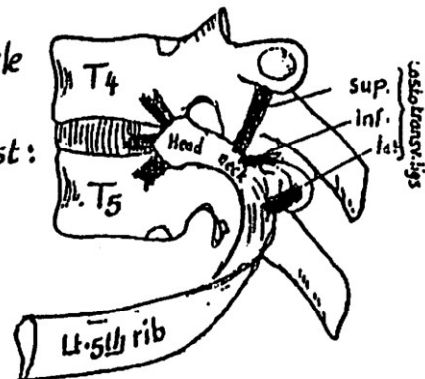
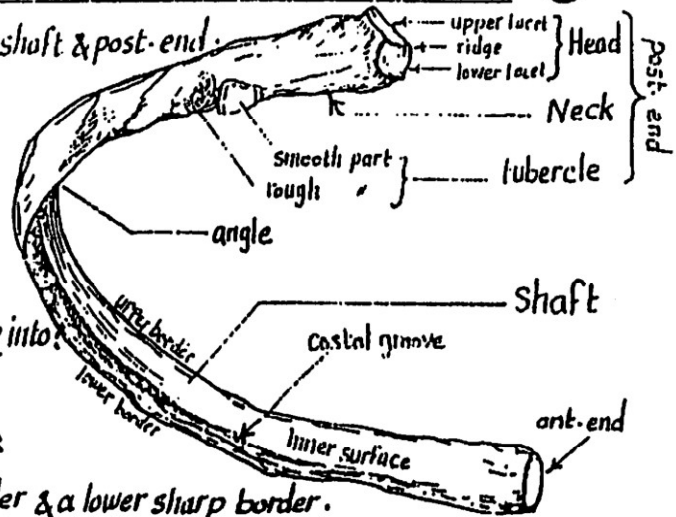
- the crest: articulates with the intervertebral disc between the 2 vertebrae.

(b) the neck: is the flattened part between the head & the tubercle. It is connected to the tr. processes of the vertebra of the same number & the vertebra above by the inf. & sup. costo transverse ligaments.

(c) the tubercle: is formed of 2 parts:

(1) medial smooth part: articulates with the transverse pr. of the vertebra of the same number.

(2) lateral rough part: gives attachment to the lat. costo-transverse lig. connecting it with the transverse process of the vertebra of the same number.



* Identification of the side of the typical rib (Rt. or Lt.):

- upwards: the rounded upper border of the shaft.

- medially: the shaft is concave medially.

- anteriorly: the ant-end has a cup-shaped concavity.

I- First rib:

Non-typical ribs

* It is the highest, flattest, strongest, most curved & most fixed rib.

* General features:

(1) Head : is small & has one facet which articulates with a circular facet on the body of the 1st thoracic vertebra.

(2) Neck : is rounded & slopes obliquely downwards.

(3) Tubercle : is prominent & coincides with the angle

(4) the Shaft : is flattened & has 2 surfaces & 2 borders:

- the upper surface : is rough & shows the following features:

(a) scalene tubercle : a prominent tubercle on the inner border
(for the insertion of scalenus ant. muscle).

(b) groove for subclavian v. : crosses the upper surface in front of scalene tubercle.

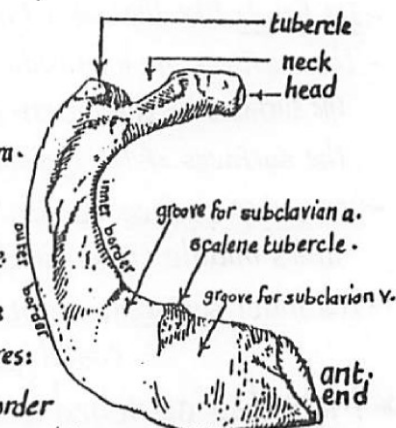
(c) groove for subclavian a. & lower trunk of brachial plexus : crosses the upper surface behind the scalene tubercle.

- the lower surface : is smooth, has no costal groove & is related to the pleura.

- the inner border : is concave & shows the scalene tubercle.

- the outer border : is convex & shows a rough impression (serrate tubercle).

(5) the anterior end : is thick, flattened & gives attachment to the 1st costal cartilage.



* Particular features of the 1st rib:

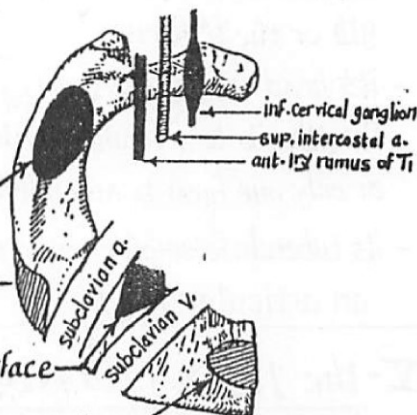
A-muscles attached : (4 "S" muscles) :

(1) scalenus medius : inserted into post. part of upper surface

(2) serratus ant. : arises from the middle of the outer border
& the upper surface of the shaft

(3) scalenus ant. : inserted into the scalene tubercle on the med. border & extends on the upper surface

(4) subclavius m. : arises from the most ant. part of upper surface



B-relations of the neck of the 1st rib : 3 structures cross in front of the neck :

(1) the inferior cervical sympathetic ganglion : ----- most medially.

(2) the ant. primary ramus of the 1st thoracic n. : ----- most laterally.

(3) the superior intercostal a. ----- in between the previous 2.

* Identification of the side of the 1st rib (Rt. or Lt.)

- the upper surface is rough while the lower surface is smooth.

- the ant. end is large & cup-shaped while the post. end carries a small head.

- the outer border is convex while the inner border is concave.

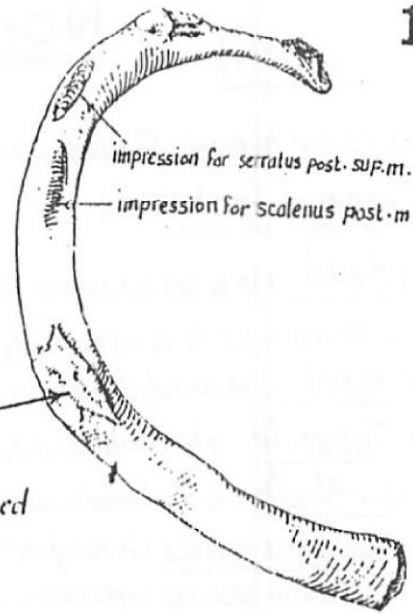
} if you put it correctly both the head & the ant. end will touch the table at the same time.

II- Second rib :

10

* General features :

- Length: twice as long as the 1st rib.
- Its head: like that of a typical rib.
- the surfaces are intermediate in direction between the surfaces of the 1st rib (upper & lower) and the surfaces of the typical rib (outer & inner).
- its outer surface carries a broad tubercle at its middle (for origin of serratus ant. m.).
- its inner surface is smooth & has poorly developed costal groove.

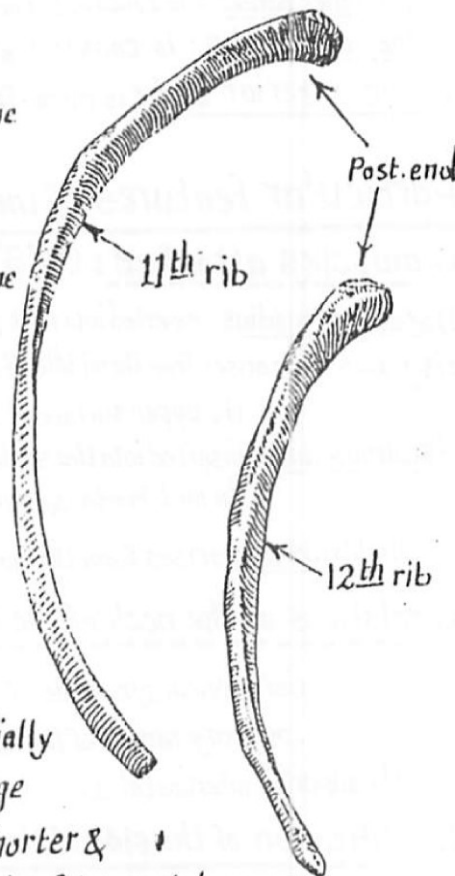


* Muscles attached to the 2nd rib:

- (1) Serratus ant. m.: arises from the broad tubercle on the middle of the outer surface.
- (2) Scalenus post. m.: inserted into the outer surface behind the origin of serratus ant.
- (3) Serratus post. sup.: " " " " " " " " insertion of scalenus post.

III The 10th rib:

- it is a transitional rib so it may look like the 9th or the 11th rib.
- its head: may have 2 articular facets like the 9th rib to articulate with T₉ & T₁₀ vertebrae or only one facet to articulate with T₁₀.
- its tubercle is small & may or may not have an articular facet.



IV- the 11th & 12th ribs:

- * each of them has:
 - a large head with single articular facet
 - no neck, no tubercle, no angle
 - the inner surface is directed upwards & medially
 - the ant-end is pointed & tipped with cartilage
- * the 12th rib differs from the 11th in being shorter & having NO costal groove (the 11th rib has a faint costal groove).

* CLINICALLY IMPORTANT POINTS RELATED TO RIBS : see page 97.

Lines of demarcation of thorax 11

(1) Midsternal line: is the line in the median plane.

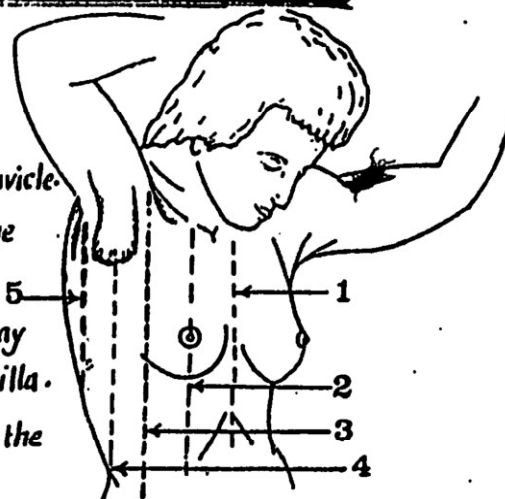
(2) Midclavicular line: is the line running vertically downwards from the midpoint of clavicle.

(3) Ant. axillary line: runs vertically downwards from the ant. axillary fold.

(4) Midaxillary line: runs vertically downwards midway between the ant. & post. folds of axilla.

(5) Post. axillary line: runs vertically downwards from the post. fold of axilla.

(6) the scapular line: a vertical line on the post. thoracic wall passing through inf. angle of scapula.



The levels & planes of the thorax

(1) the plane of the inlet of thorax:

extends from the upper border of manubrium to the upper border of the body of the 1st thoracic vertebra.

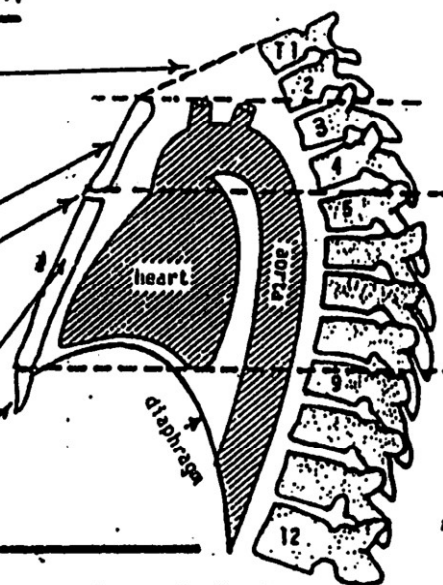
(2) the manubrium: lies opposite T₃ & T₄ vertebrae.

(3) the plane of the sternal angle:

extends from lower border of manubrium to the lower border of T₄ vertebra.

(4) the body of sternum: lies opposite T₅-8 vertebrae.

(5) the xiphoid process: lies opposite T₉ vertebra.



Cutaneous innervation of the Chest Wall

(A) Above the level of the sternal angle:

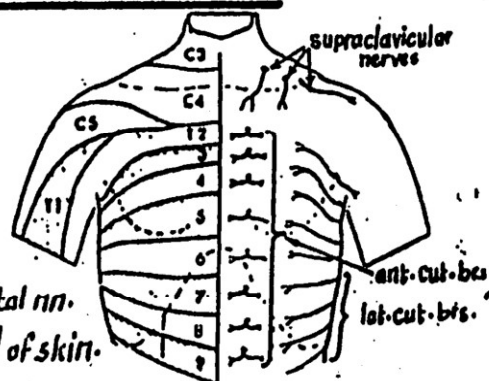
the skin of the ant. chest wall is supplied by the supraclavicular nerves (C₃, 4).

(B) Below the level of the sternal angle:

the skin of the ant. chest wall is supplied by the lat. & the ant. cutaneous branches of intercostal nn.

N.B: the branches of each n. supply an oblique band of skin.

(C) the skin of the post. chest wall is supplied by the post. rami of the thoracic nerves.



The Intercostal Spaces

12

* Definition: the intercostal space is the space between each 2 successive ribs.

There are 11 intercostal spaces between the 12 ribs on either side & each space lies below the numerically corresponding rib i.e the 1st space lies below the 1st rib.

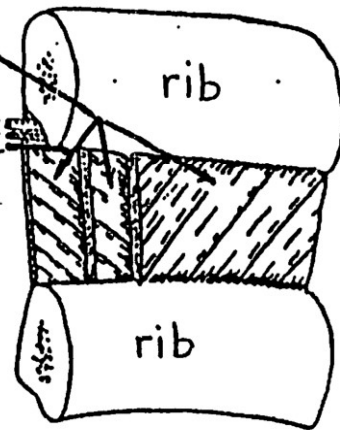
* Structure: each intercostal space contains:

(A) Intercostal muscles & membranes arranged in 3 layers.

(B) a neurovascular bundle consisting of: (1) intercostal V.

(2) intercostal a.

(3) intercostal n.



(A) Intercostal Muscles

* they are arranged in 3 layers in each space:

(1) outer layer: the external intercostal muscle.

(2) middle " : the internal " " "

(3) inner layer: the transversus thoracis muscle: it is an incomplete layer formed of 3 separate muscles: (a) Sternocostalis m. (b) innermost intercostal & subcostalis m.

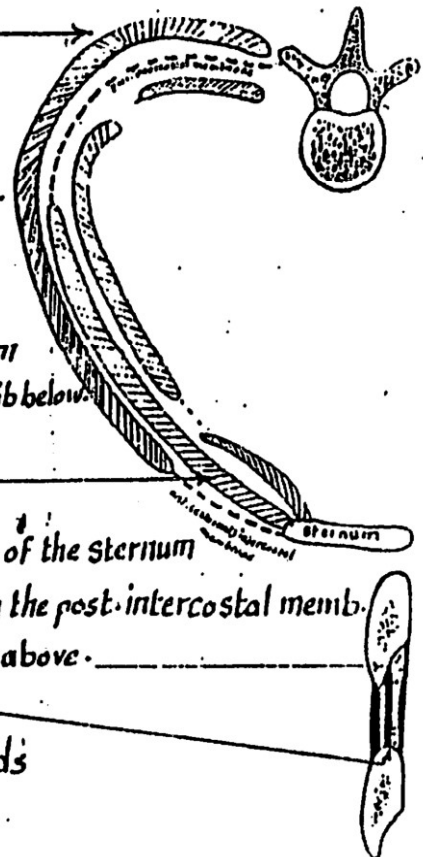
(1) External intercostal muscle

* Extension: it begins posteriorly at the tubercle of the rib & ends anteriorly at the Costo-chondral junction by becoming the ant. intercostal membrane extending to sternum.

* Origin: from the lower border of the rib above.

* Insertion: into the upper border of the rib below.

* direction of fibres: obliquely downwards & forwards from the lower border of the rib above to the upper border of the rib below.



(2) Internal intercostal muscle

* Extension: it begins anteriorly at the lateral margin of the sternum & ends posteriorly at the angle of the rib by becoming the post. intercostal memb.

* Origin: from the floor of the costal groove of the rib above.

* Insertion: into the upper border of the rib below.

* Direction of fibres: obliquely downwards & backwards

(3) the transversus thoracis muscle

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* It is formed of 3 separate muscles :

(A) Innermost intercostal m.

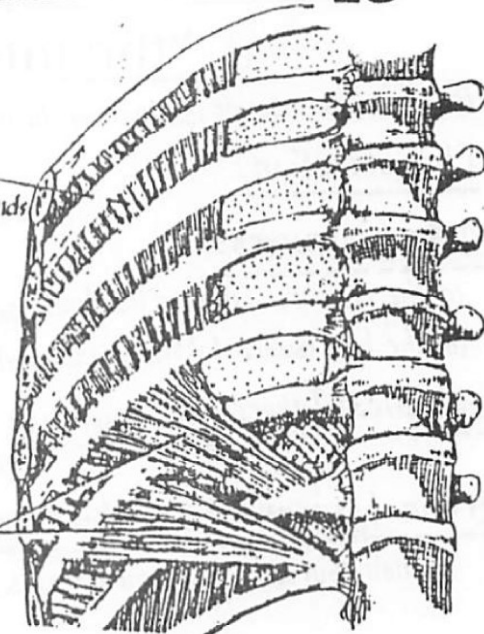
* Extension : begins in front of the midaxillary line & extends backwards to end at the angle of the rib.

* Origin : upper border of costal groove of the rib above.

* Insertion : into the upper border of the rib below.

* direction of fibres : as the internal intercostal m.

* N.B : the neurovascular bundle passes between the internal intercostal & the innermost intercostal m.



(B) Subcostalis muscle :

* It is formed of thin muscular bands lying at the post. part of the inner surface of the chest wall mainly in the lower part.

* Origin : each band arises from the inner surface of the rib above

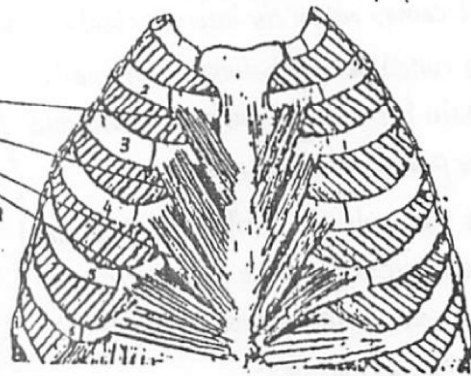
* Insertion : " " Crosses one or 2 ribs to be inserted into upper border of the 2nd or the third rib below.

(C) Sternocostalis muscle :

* It lies in the ant. part of the inner surface of the chest wall extending from the back of sternum to the costal cartilages from 2 to 6

* Origin : 4 or 5 slips from the post. surface of the lower $\frac{1}{2}$ of the sternum.

* Insertion : the slips run upwards & laterally to be inserted into the inner surfaces of the Costal Cartilages from the 2nd to the 6th.



* N. Supply of the intercostal muscles :

they are supplied by the corresponding intercostal nerves & their collateral branches.

* Action of the intercostal muscles :

(1) the external intercostals elevate the ribs during inspiration.

(2) the internal intercostals & transversus thoracis depress the ribs & costal cartilages during expiration.

(3) all muscles prevent the inward suction of the intercostal spaces during inspiration or their outward puffing during expiration.

Nerve supply of thoracic wall 14

"the intercostal nerves"

* They are the anterior rami of the thoracic nerves. There are 11 intercostal & one subcostal nerve.

* Classification:

- 2 Special nerves:

- (a) the 1st nerve: most of its fibres ascend to join the brachial plexus.
- (b) the last (subcostal) nerve: runs all its course in the abdominal wall.

- 5 typical Intercostal nerves: From the 2nd to the 6th nerves: they run all their course in the thoracic wall.

- 5 non-typical intercostal nerves: From the 7th to the 11th nerves: they run part of their course in the thoracic wall & part in the abdominal wall.

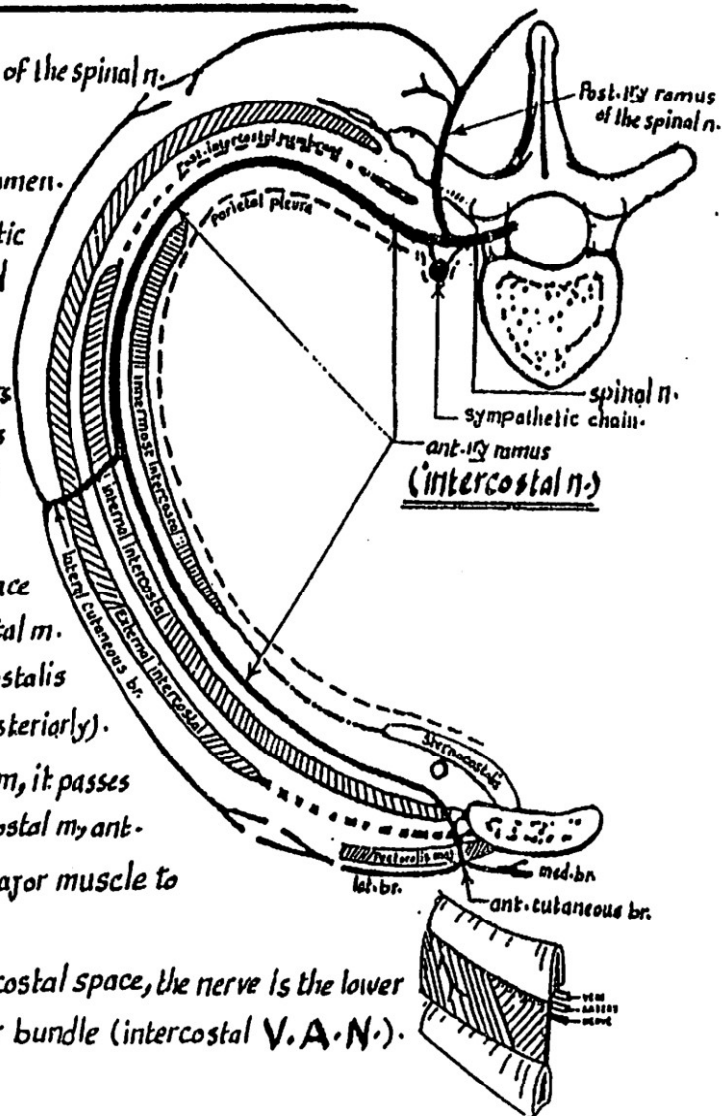
Anatomy of a typical intercostal nerve (2-6)

- Origin: it arises as the ant. rami of the spinal n.

- Course & relations:

- (1) it comes out of the intervertebral foramen.
- (2) it runs laterally behind the sympathetic chain between the parietal pleura and the post. intercostal membrane.
- (3) at the angle of the rib, the nerve enters the intercostal space running forwards between the innermost & the internal intercostal muscles.
- (4) at the ant. part of the intercostal space it lies between the internal intercostal m. (anteriorly) & parietal pleura, sternocostalis m. & internal mammary vessels (posteriorly).
- (5) about 1/2 an inch lateral to the sternum, it passes forwards, piercing the internal intercostal m., ant. intercostal membrane & pectoralis major muscle to end as the ant. cutaneous nerve.

N.B.: throughout its course in the intercostal space, the nerve is the lower structure of the neurovascular bundle (intercostal V.A.N.).



* Branches of the typical intercostal n.:

(1) Ganglionic branches: each n. gives a white ramus communicans (preganglionic) to, and receives a gray ramus communicans (postganglionic) from the corresponding ganglion of the sympathetic chain.

(2) Collateral branch (motor): runs along the upper border of the rib below & supplies the intercostal muscles.

(3) Lateral cutaneous br.: passes laterally in the mid-axillary line piercing the muscles of the intercostal space & serratus ant. m. to reach the skin where it divides into ant. & post. branches supplying the skin of the side of the chest.

(4) Anterior cutaneous br.: it is the termination of the intercostal n. It divides into med. & lat. branches which supply the skin of the front of the chest.

(5) Muscular branches: from the main n. & its collateral br. to supply the intercostal muscles.

(6) Pleural & peritoneal branches: to the parietal layers of these serous membranes.

(7) Articular branches: to the joints of the ribs.

N.B: the intercostobrachial n.: is the lat. cutaneous br. of the 2nd intercostal n. which, unlike the others, does not divide into ant. & post. branches but passes laterally to supply the axilla.

* CLINICALLY IMPORTANT POINTS RELATED TO INTERCOSTAL NERVES : see page 97.

The non-typical intercostal n.

"thoraco-abdominal nerves"

* They are the lower 5 intercostal nerves (from 7 to 11).

* They run the same course as the typical intercostal nerves till they reach the ant. ends of the intercostal spaces.

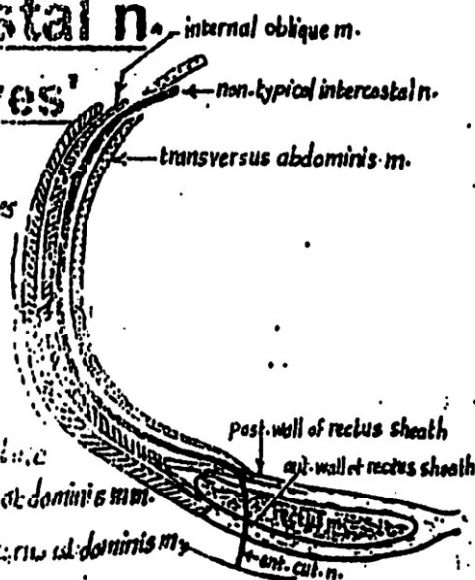
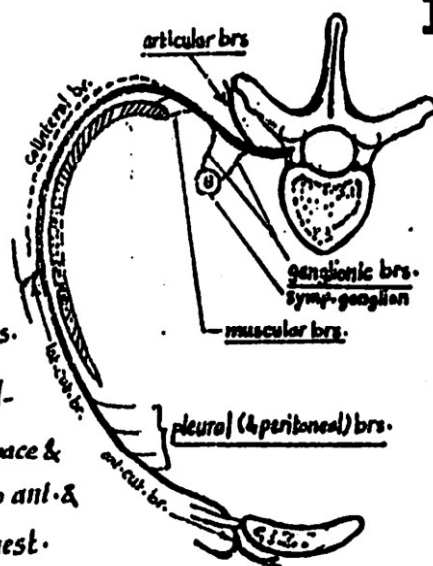
* Course & relations in the ant. abdominal wall:

(1) they enter the ant. abd-wall by passing between the fibers of origin of the transversus abdominis m.

(2) then they run forwards & medially in the neurovascular plane of the ant. abd-wall between internal oblique & transversus abdominis m.

(3) each n. ends by piercing the post-wall of rectus sheath, the transversus abdominis m. & the ant-wall of the rectus sheath to become the ant. cut. n.

* Branches: the same as those of the typical nerves. In addition it gives branches to the abdominal muscles & supplies the skin of the ant. abd-wall.



Arterial supply of the thoracic wall **16**

"the Intercostal arteries"

- * The intercostal spaces are supplied by 2 sets of intercostal arteries :
 - ant. intercostal aa.
 - post

(A) The anterior intercostal arteries:

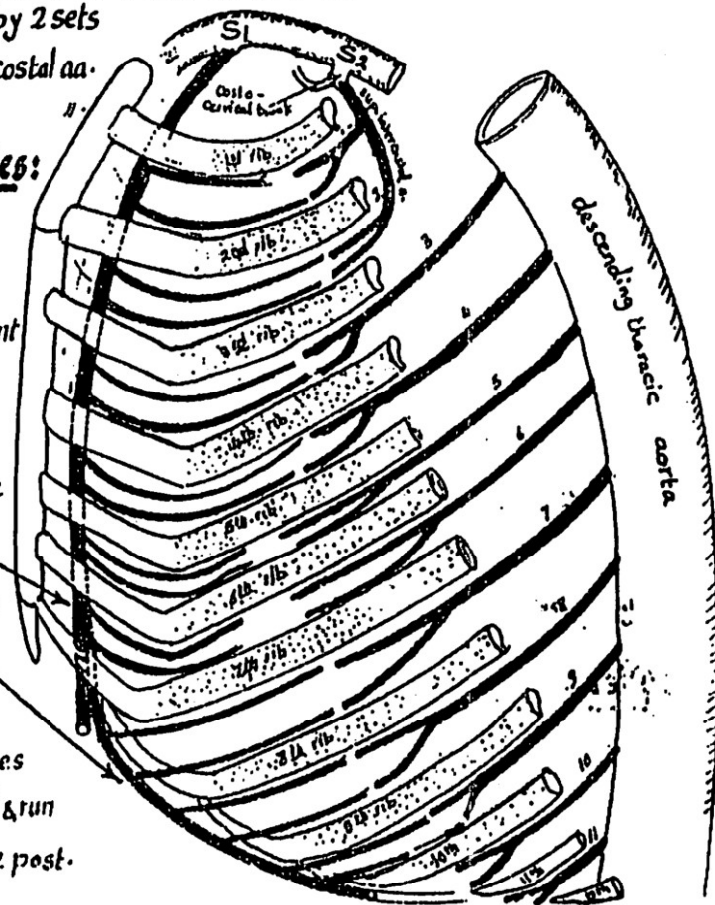
- * number: there are 2 ant. intercostal aa. in each of the upper 9 intercostal spaces (No ant. intercostal aa. are present in the 10th & 11th spaces).

* Origin:

- in the upper 6 spaces, the arteries are branches of the Internal mammary a.
- in the 7th, 8th & 9th spaces, the arteries are branches of the musculo-phrenic a.

* Course:

- the 2 arteries of each of the upper 9 spaces enter the intercostal space at its ant. end & run laterally to end by anastomosing with the post. intercostal a. & its collateral branch.



(B) The posterior intercostal arteries:

- * Number: there is one posterior intercostal a. in each of the 11 intercostal spaces.

* Origin:

- the arteries of the 1st & 2nd spaces are branches of the sup. intercostal a. which is a branch of the Costocervical trunk arising from the 2nd part of subclavian a.
- the arteries of the remaining intercostal spaces (from 3 to 11) are branches of the descending thoracic aorta.

* Course:

- each post. intercostal a. enters the intercostal space at its post. end. It runs laterally then forwards in the Costal groove below the intercostal vein.
- it gives a collateral branch which runs along the upper border of the rib below.
- the post. intercostal & its collateral br. end by anastomosing with the 2 ant. intercostal arteries.

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***Course:**

-

(1) sup. epigastric a. —
(2) musculophrenic a.

(A) Anteriorly: (i) sternal end of the clavicle.

- * Branches : $(4 P_s + 5 M S M)$:

- (1) Pair of anterior intercostal arteries to each of the upper 6 intercostal spaces.
- (2) Perforating brs. : which pierce the upper 6 spaces with the ant. cutaneous brs. of the corresponding intercostal nerves. Those of the 2nd, 3rd & 4th spaces supply the mammary gland before reaching the skin.
- (3) Pericardiaco-phrenic a. : descends in company with the phrenic n. to supply pericardium, diaphragmatic pleura & upper surface of the diaphragm.
- (4) Pericardial brs. : to upper part of pericardium.
- (5) Sternal brs. : to sternocostalis muscle & back of the sternum.
- (6) Mediastinal brs. : to the contents of ant. mediastinum (L.Ns & remnants of thymus gland).
- (7) Musculophrenic a. (one of the 2 terminal brs.) : it runs along the costal margin to supply the diaphragm. It gives a pair of ant. intercostal aa. to the 7th, 8th & 9th spaces.
- (8) Sup. epigastric a. (the other terminal br. :
 - it runs downwards traversing the diaphragm (between the sternal & costal origins) to enter the rectus sheath in the ant. abdominal wall. Its subsequent course is described in the abdomen.

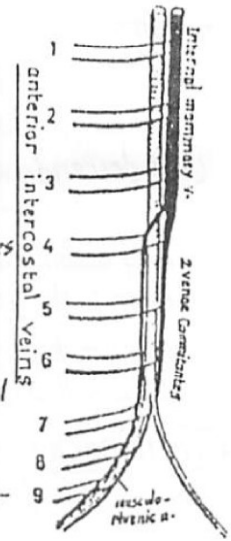
Venous drainage of chest wall 18

(the Intercostal veins)

(A) Anterior intercostal veins: correspond to the ant. intercostal arteries i.e 2 veins in each space.

- the ant. intercostal vv. of the 9th, 8th & 7th spaces: join the venae comitantes of the musculophrenic a.
- " " " " " 6th, 5th & 4th spaces: join the venae comitantes of the internal mammary a.
- " " " " " 3rd, 2nd & 1st spaces join the internal mammary v.

N.B: the venae comitantes of the int. mammary a. unite opposite the 3rd intercostal space to form the internal mammary v. which ends in the innominate v.



(B) Posterior intercostal veins:

- there are 11 post. intercostal veins on each side (one in each space).
- they have different arrangement on both sides:

I- on the right side:

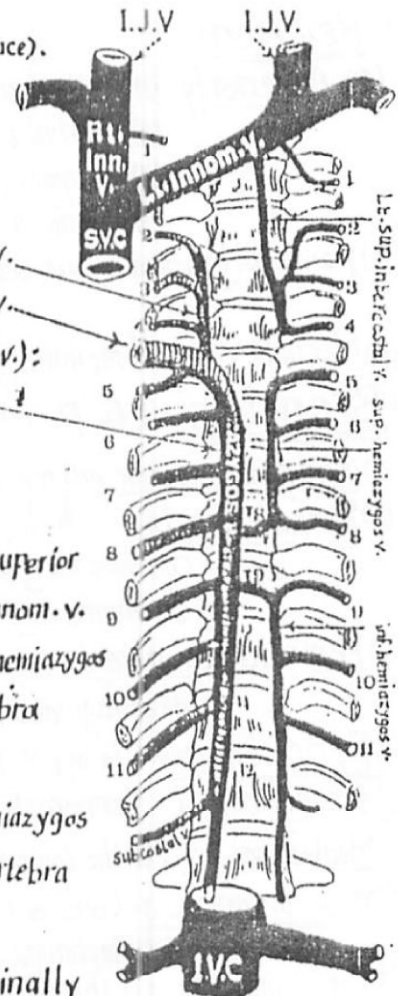
- (1) the 1st vein ends in the Rt. innominate vein.
- (2) the 2nd, 3rd & 4th veins: unite to form Rt. sup. intercostal v. which ends in the arch of azygos v.
- (3) the remaining veins (from the 5th to the 11th & the subcostal v.): end separately in the azygos vein.

II- on the left side:

- (1) the 1st vein: ends in the Lt. innominate v.
- (2) the 2nd, 3rd & 4th veins: unite together to form the Lt. superior intercostal v. which opens into Lt. innom. v.
- (3) the 5th, 6th, 7th & 8th veins: end in the superior (accessory) hemiazygos vein which turns to the right crossing the body of T8 vertebra to open into the azygos vein.
- (4) the 9th, 10th, 11th & the subcostal vein end in the inf. hemiazygos vein which turns to the right crossing the body of T9 vertebra to open into the azygos vein.

N.B: (1) all the venous blood of the thoracic wall drains finally into the superior vena cava (S.V.C).

(2) for the detailed anatomy of the S.V.C. & Azygos & hemiazygos veins: see pages: 71, 72, 73.



The thoracic inlet

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* Boundaries:

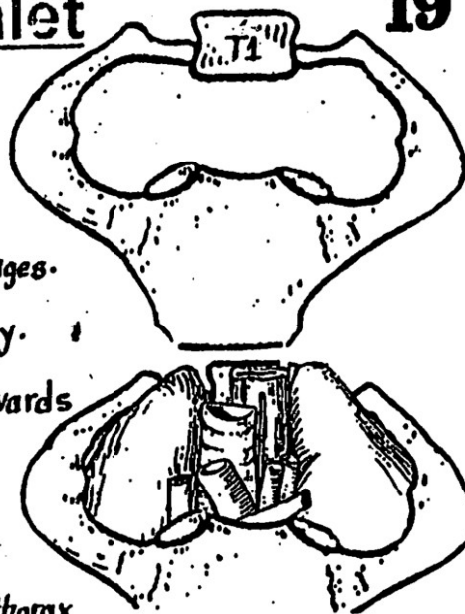
- anteriorly : the upper border of the manubrium.
- posteriorly : the body of the 1st thoracic vertebra.
- on either side : the 1st pair of ribs & their costal cartilages.

* Shape & Size : it has the shape & size of a kidney.

* Its plane : is oblique, sloping downwards & forwards

* Important structures passing through it :

- the median part of the thoracic inlet transmits the structures that pass inbetween the neck & the thorax.
- on each side of these structures, the apex of the lung projects for a short distance covered by the cervical pleura & a tent-shaped strong fascial layer called suprapleural membrane.
- the following are the important structures passing through the thoracic inlet :



(A) Viscera	(B) Arteries	(C) Veins & Lymphatics	(D) Nerves
(1) Trachea	(1) Innominate a.	(1) Rt. Innominate v.	(1) Rt. & Lt. Vagus
(2) Oesophagus	(2) Lt. Common carotid a.	(2) Lt. " "	(2) Rt. & Lt. phrenic
(3) apices of Rt. & Lt lung	(3) Lt. subclavian a.	(3) Thoracic duct.	(3) Rt. & Lt. symp. chain.
			(4) Lt. recurrent laryngeal n.
			(5) Rt. & Lt. ant. rami of 1st thoracic nerves

The Suprapleural membrane (Sibson's fascia)

* It is the upper thickened part of the endothoracic fascia forming a tough membrane stretching across the inlet of thorax on either side.

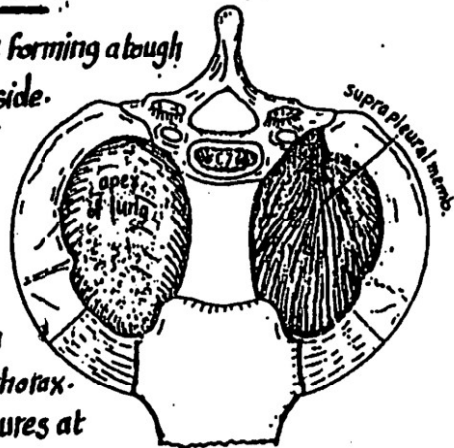
* Shape : triangular, having an apex & a base.

* Attachments :

- the apex is attached to the tr. process of C7 vertebra.
- the base : is attached to the med. border of the 1st rib & 1st costal cartilage. Medially, it blends with the fascia investing the structures passing inbetween the neck & thorax.

* Functions : (1) it prevents the inward suction of the structures at the root of the neck with every inspiratory movement.

(2) it prevents the upward puffing of apex of lung during expulsive expiratory efforts.



The thoracic outlet

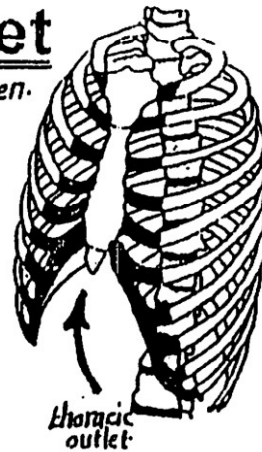
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* It is the lower opening of the thoracic cage at its junction with abdomen.

* Boundaries:

- anteriorly : the xiphoid process.
- posteriorly : T12 vertebra & the 11th & 12th ribs of both sides.
- on either side : the costal margin (7th, 8th, 9th & 10th costal cartilages fused together).

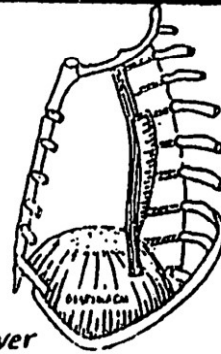
* the thoracic outlet is closed by the diaphragm which is pierced by many structures on their way to or from the abdomen.



The Diaphragm

* Nature & shape:

- it is a large dome-shaped musculo-tendinous partition which separates the thoracic cavity from the abdominal cavity.
- its upper surface is convex towards the thoracic cavity while its lower surface is concave towards the abdominal cavity.
- its right side (called Rt. cupola) bulges higher up than its left side (Lt. cupola) due to the upward bulge of the underlying Rt. lobe of the liver.



* Origin of the diaphragm:

- the peripheral part of the diaphragm takes origin from the circumference of the outlet of the thorax. The origin is divided into 3 parts:

(1) Sternal origin: by 2 slips from the back of the xiphoid process.

(2) Costal origin: by slips from the inner surfaces of the lower 6 costal cartilages of both sides.

(3) Vertebral origin: by 2 muscular bands (called Rt. & Lt. crura) and from 5 arched ligaments (one median, 2 medial & 2 lateral) called arcuate ligaments:

(a) the Rt. crus: arises from the bodies of the upper 3 lumbar vertebrae.

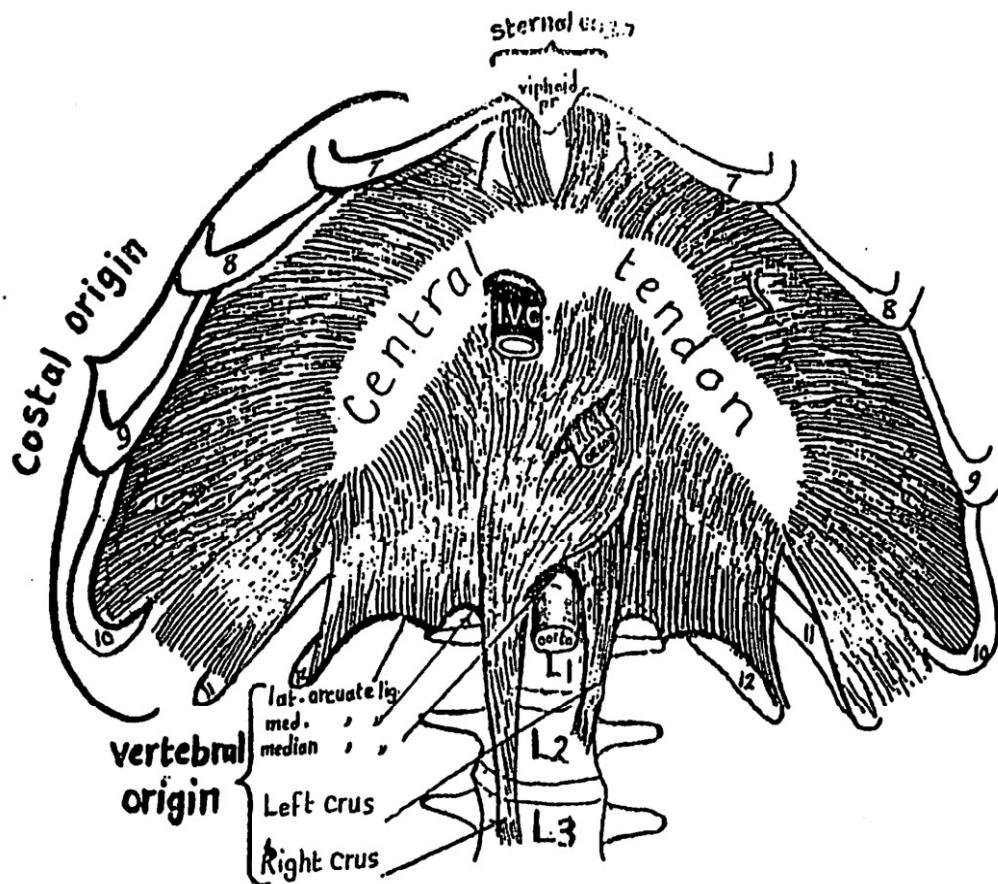
(b) the Lt. crus: " " " " " " upper 2 " "

(c) the median arcuate lig.: is a tendinous arch that connects the 2 crura together.

(d) each medial " " (Rt. & Lt.): is a tendinous arch that connects the crus with the tip of the transverse process of the 1st lumbar vertebra.

(e) each lateral arcuate lig. (Rt. & Lt.): is a tendinous arch which connects the tip of the tr. process of L1 vertebra to the last rib.

* Insertion: the fibres of the sternal, costal & vertebral parts converge to be inserted into a crescentic-shaped central tendon which is more ant. than post. in position.



* Nerve Supply:

- (1) the phrenic nerves (motor).
- (2) branches from the lower 6 or 7 intercostal nerves: sensory to the periphery of diaphragm.

* Action: the diaphragm is the main muscle of inspiration. Its contraction leads to its descent & increase in the vertical diameter of the thoracic cavity.

* the Major foramina of the diaphragm:

- Vena caval : Voice
- Oesophageal : Of
- Aortic : America

Opening	Vena Caval opening	Oesophageal O.	Aortic opening
Vertebral level	T8	T10	T12
Position	1" to the Rt. of middle line piercing the central tendon.	1" to the Lt. of middle line piercing the Rt. crus of diaphragm.	in the middle line behind the median arcuate lig. of diaphragm.
Structures passing	(1) the I.V.C (2) Rt. phrenic n. (3) lymphatics from the liver to thoracic L.Ns	(1) Oesophagus (2) the ant. & post. gastric nn. (originally Lb & Rt. vagi). (3) oesophageal br. of Lt. gastric a.	(1) descending aorta (2) Azygos vein. (3) thoracic duct.

* Other structures passing through the diaphragm: S, S, S

22

(1) the **S**planchnic nerves : pierce the crura of the diaphragm.

(2) the **S**ympathetic trunks : pass behind the med. arcuate lig.

(3) the **S**up. epigastric a. : passes between the slip of sternal origin & the 1st slip of costal origin.

* Relations of the diaphragm:

A-Upper surface:

(1) its central tendon is related to the pericardium & heart.

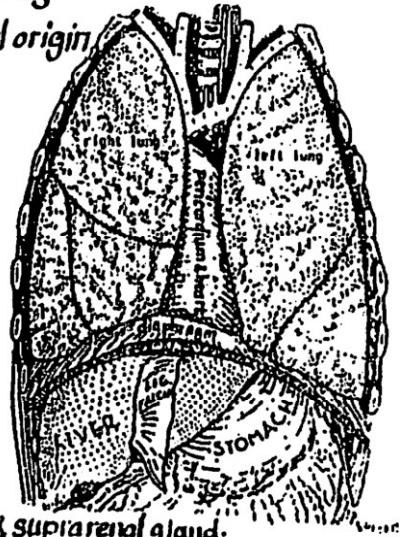
(2) the Rt. cupola is related to Rt. pleura & base of Rt. lung.

(3) the Lt. " " " " Lt. " " " " Lt. " " " " Lt. " " " "

B-Lower surface:

(1) its Rt. cupola is related to Rt. lobe of liver, Rt. kidney & suprarenal gland.

(2) its Lt. Cupola " " " " Lt. lobe of liver, fundus of stomach, Lt. kidney & suprarenal gland.



The Thoracic Cavity

(A) Lining of thoracic cavity: "The endothoracic fascia"

* definition: it is loose fibrocellular tissue that lines the thoracic wall & covers the mediastinal structures.

* extensions:

- above: it is thickened to form the suprapleural membrane. (see page 19).

- below: it covers the dome of the diaphragm.

- medially: the fasciae of both sides meet in the middle region to form the loose connective tissue of the mediastinum.

- laterally: it forms a fibro-elastic membrane which lines the thoracic wall binding the parietal pleura to the inner surfaces of the ribs & costal cartilages.

(B) Subdivisions: the thoracic cavity can be divided into:

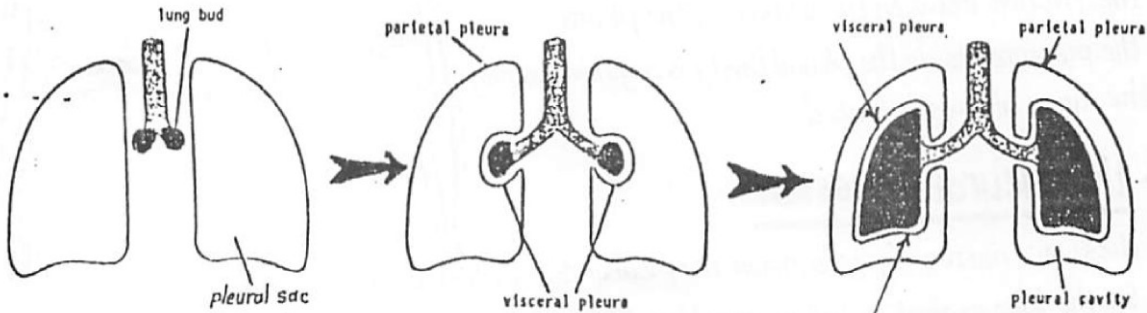
I- 2 pleural cavities: one on each side containing a lung.

II- the Mediastinum: a median partition between the 2 pleural cavities containing a number of structures.

The Pleura

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* **Definition:** it is a completely closed sac which is invaginated by the lung from its medial aspect.



* Subdivisions of the pleura:

- (1) **visceral pleura**: it is the part investing the lung & is closely adherent to it.
- (2) **Parietal pleura**: it is the part lining the thoracic cavity & has the following parts:

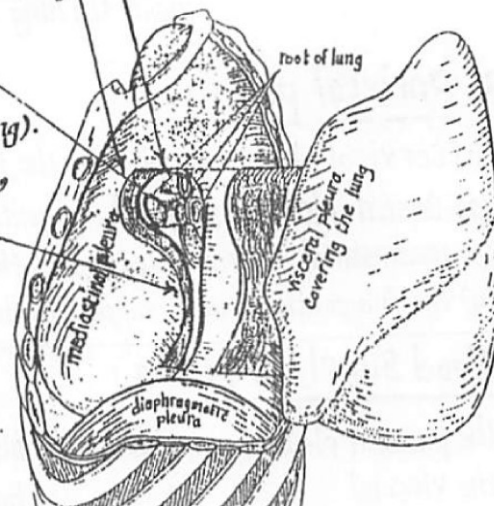
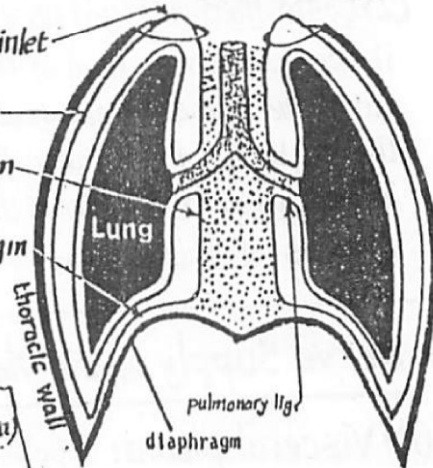
- (a) **Cervical part**: the part bulging up through the thoracic inlet
- (b) **Costal** : the part lining the ribs & intercostal spaces
- (c) **Mediastinal part**: covering the side of mediastinum
- (d) **diaphragmatic** : covering upper surface of diaphragm

(3) **Pulmonary ligament:**

- the parietal pleura covering the mediastinum (mediastinal pleura) is continuous with the visceral pleura covering the lung by a tubular sheath or sleeve of pleura.
- the upper part of this sheath contains the structures that pass to & from the lung (root of lung).
- the lower part of this tubular sheath, being empty, is collapsed & known as the **pulmonary ligament** that extends down to the diaphragm.

Significance of the pulmonary ligament:

- (1) it allows free up & down movements of the root of the lung during respiratory excursions.
- (2) it allows a dead space for the dilatation of the lower pulmonary v. during increased venous return from the lung.

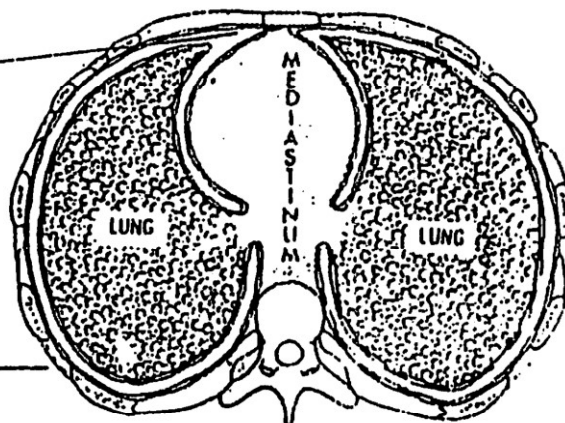


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- Diagram illustrating a coronal section of the thorax. The lungs are shown on either side of the mediastinum. The diaphragm is indicated at the bottom. Labels include: LUNG, MEDIASTINUM, and Diaphragm. A horizontal line with arrows at both ends is labeled "CORONAL SECTION". The number 24 is in the top right corner.

these are narrow spaces inside the pleural cavity which are not occupied by the lung except in full inspiration. These recesses are:

along the lower border of the pleura. In full inspiration, the inf. border of the lung extends into this recess.

it lies between the front of the thoracic wall & the mediastinum extending along the ant-border of the pleura. In full inspiration the ant-border of the lung extends into this recess.



(A) Visceral pleura: supplied by vagal & sympathetic autonomic nerve plexuses inside the lung. It is insensitive to normal stimuli.

(1) Cervical pleura: supplied by the 1st intercostal n.

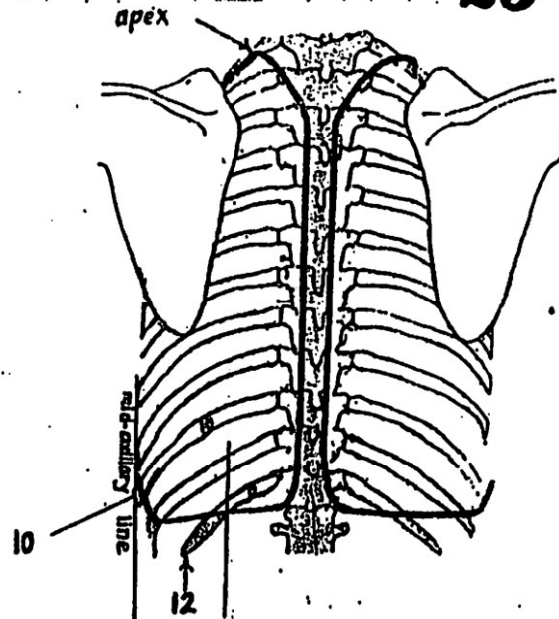
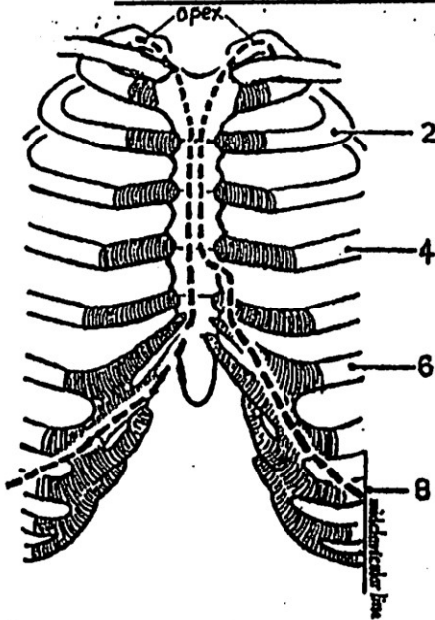
(2) Costal pleura: supplied segmentally by the intercostal nerves.

(3) mediastinal pleura: supplied by the phrenic nerves.

(4) diaphragmatic pleura : supplied by the phrenic nerves & lower intercostal nerves.

- the parietal pleura is supplied by the intercostal & internal mammary vessels.
- the visceral " " " " " bronchial vessels.

Surface anatomy of the pleura 25



	Right pleura	Left Pleura
1-Apex (cervical pleura)	represented on both sides by a curved line (convex upwards) starting from the point of junction between the middle $\frac{1}{3}$ & medial $\frac{1}{3}$ of the clavicle & passing downwards & medially to a point at the sternoclavicular joint.	
2-Ant. border	(1) it begins from the point of the sternoclavicular joint & passes downwards & medially to meet its fellow of the Lt. side in the middle line at the sternal angle. (2) the ant. border of the Rt. pleura descends vertically (without deviation) close to the middle line till the level of the 6th costal cartilage where it ends.	(1) it begins from the point of the sternoclavicular joint & passes downwards & medially to meet its fellow of the Rt. side in the middle line at the sternal angle. (2) the ant. border then descends vertically to the level of the 4th costal cartilage (3) then it descends close to the left margin of the sternum from the 4th c. cartilage to the 6th c. cartilage where it ends
3-Inf. border	represented on both sides by a line starting at the 6th costal cartilage (where the ant. border ends) & passing backwards around the chest wall crossing: - the 8th rib in the midclavicular line. - the 10th rib in the midaxillary line. - the 12th rib opposite the lat. border of sacrospinalis m. then extends to the level of the 12th thoracic spine where it ends.	
4-post. border	is represented on both sides by a vertical line starting close to the 12 th thoracic spine (where the inf. border ends) & ascending upwards alongside the vertebral column to end at the point of the apex of pleura.	

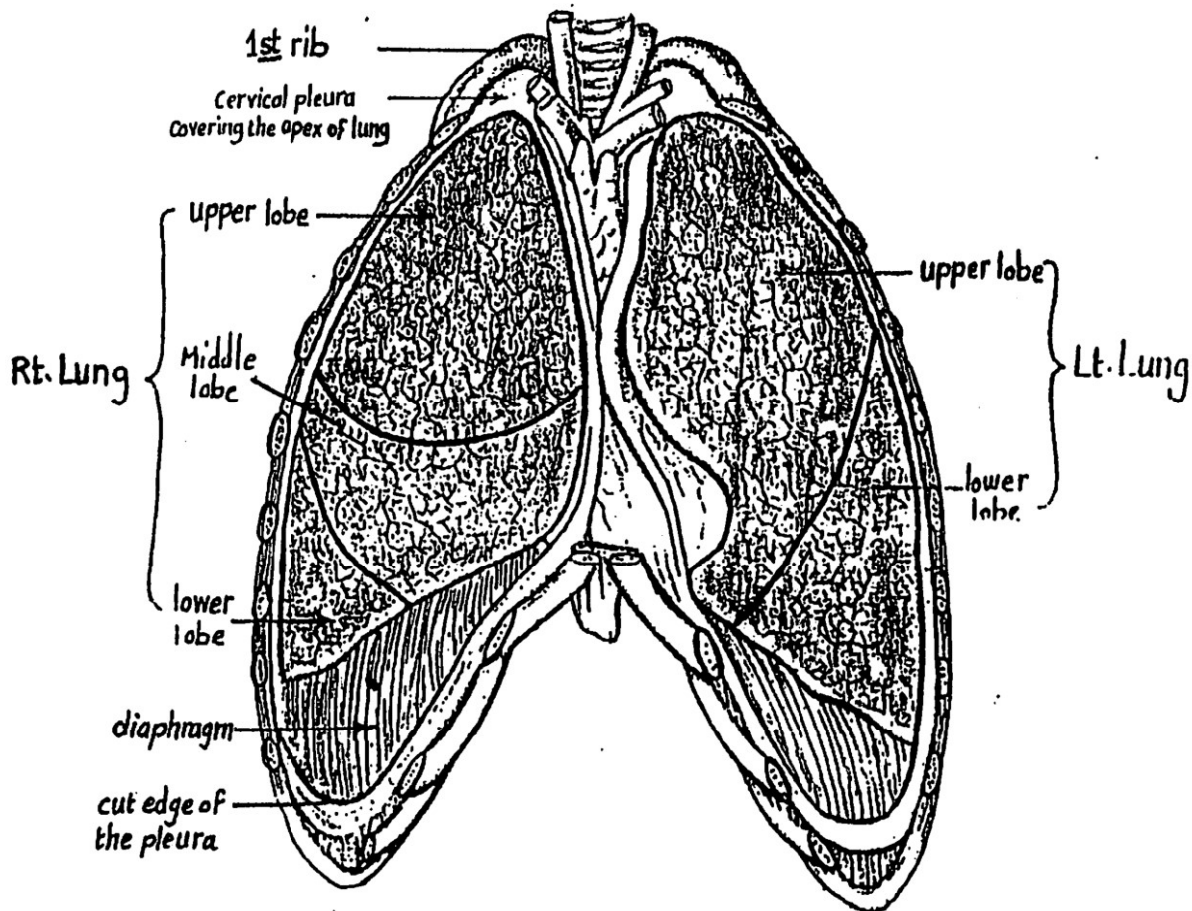
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CLINICALLY IMPORTANT POINTS RELATED TO PLEURA

see page 98.

The Lung

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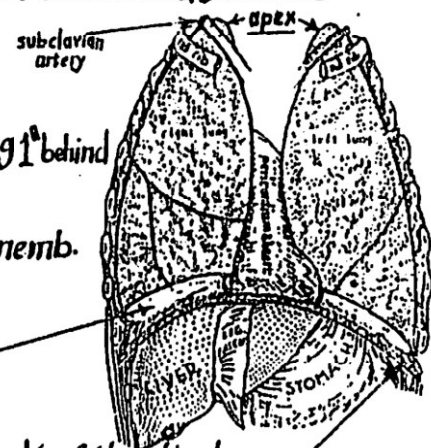


* The lungs are the organs of exchange of gases between blood & atmospheric air.

* **Shape:** each lung looks like half cone with an apex, base, 2 surfaces & 3 borders.

(1) Apex:

- projects upwards through the thoracic inlet extending 1" behind & above the med. third of the clavicle
- it is covered by the cervical pleura & supra pleural memb.
- it is grooved anteriorly by the subclavian a.



(2) Base or diaphragmatic surface:

- is concave & rests on the cupola of the corresponding $\frac{1}{2}$ of the diaphragm
- the base of the Rt. lung is more concave & separated by the diaphragm from the Rt. lobe of the liver
- the base of the Lt. lung is less concave & separated by the diaphragm from the Lt. lobe of liver, fundus of stomach & spleen.

(3) Surfaces : 2 : costal & medial :

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A-Costal surface:

is wide, convex & is related to the ribs and the intercostal spaces.

(B) Medial surface:

contains the hilum of the lung.
It is divided into 2 parts :

(1) Ant. or mediastinal part : presents grooves and impressions corresponding to the structures in the side of the mediastinum (see page).

The hilum lies in the post part of the mediastinal surface.

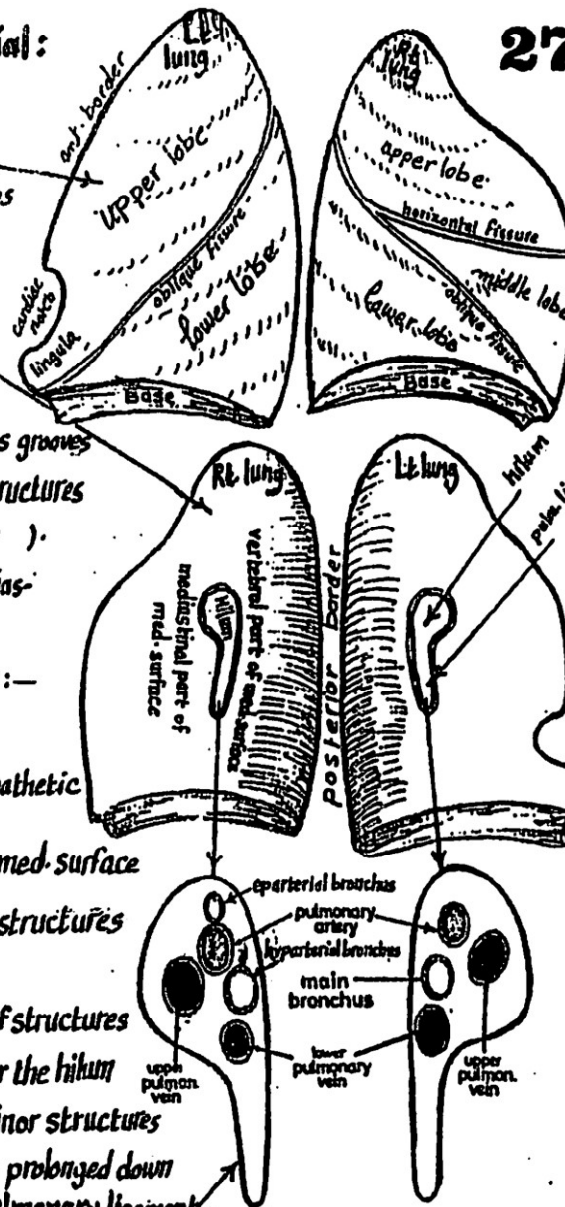
(2) post. or vertebral part (behind hilum) : — related to the bodies of the thoracic vertebrae, intercostal n. & vessels & sympathetic chain.

* The Hilum : it is the area on the med. surface of the lung which gives passage to the structures form in the root of the lung

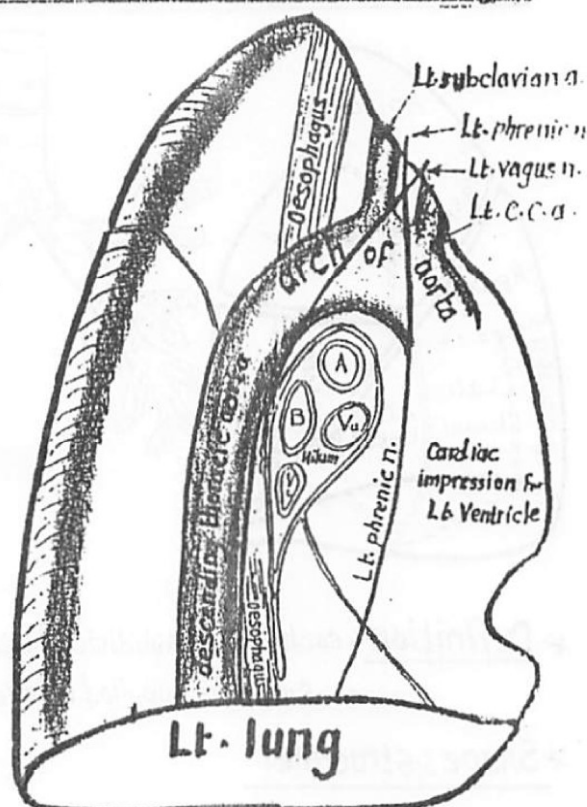
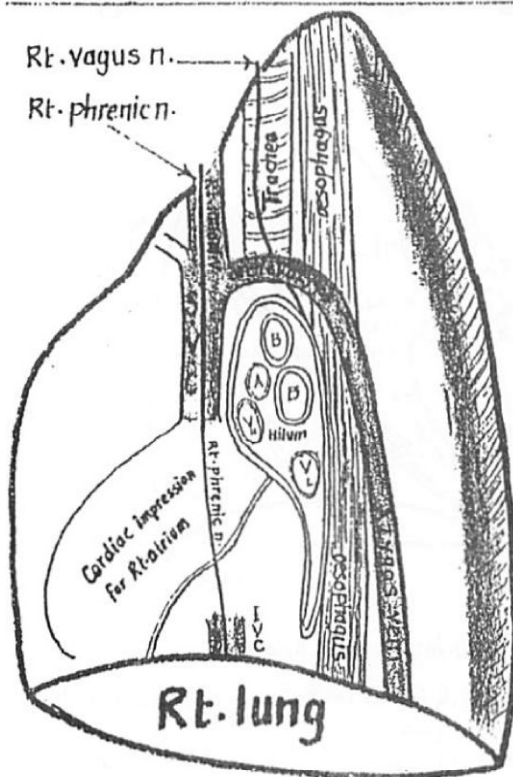
* The Root of the lung : it is the group of structures which pass from the mediastinum to enter the hilum of the lung. They include 3 major & 3 minor structures surrounded by a tubular sheath of pleura prolonged down below the root of the lung to form the pulmonary ligament.

* Structures forming the root of the lung :

Major Structures	Minor structures
(1) <u>Bronchus</u> : occupies a post. position . In the <u>Rt. hilum</u> the main bronchus divides before entering into 2 : eparterial bronchus above the pulmonary a. & hyparterial bronchus below the pulmonary a. (2) <u>Pulmonary a.</u> : in the <u>Lt. hilum</u> it occupies the upper part of the hilum. In the <u>Rt. hilum</u> it lies between the eparterial & hyparterial bronchi (3) <u>2 pulmonary veins</u> : the upper pulmonary v. is the most ant. structure in the hilum. The lower pulm. v. is the most inferior structure in the hilum.	(1) <u>Bronchial vessels</u> : are slender vessels lying on the post. aspect of the bronchus. They supply the bronchial tree & the stroma of the lung. The <u>left lung</u> has 2 bronchial a.a. arising from the descending aorta. The <u>Rt. lung</u> has only one artery arising from the 3rd Rt. post. intercostal a. (2) <u>Ant. & post. pulmonary plexuses</u> : lying in front & behind the main structures of the hilum. They are formed of symp. & parasymp. fibres that supply the bronchial tree, lung & visceral pleura. (3) <u>Broncho-pulmonary lymph nodes</u> : lying in between the major structures of the hilum. They drain the lymph of the lung.

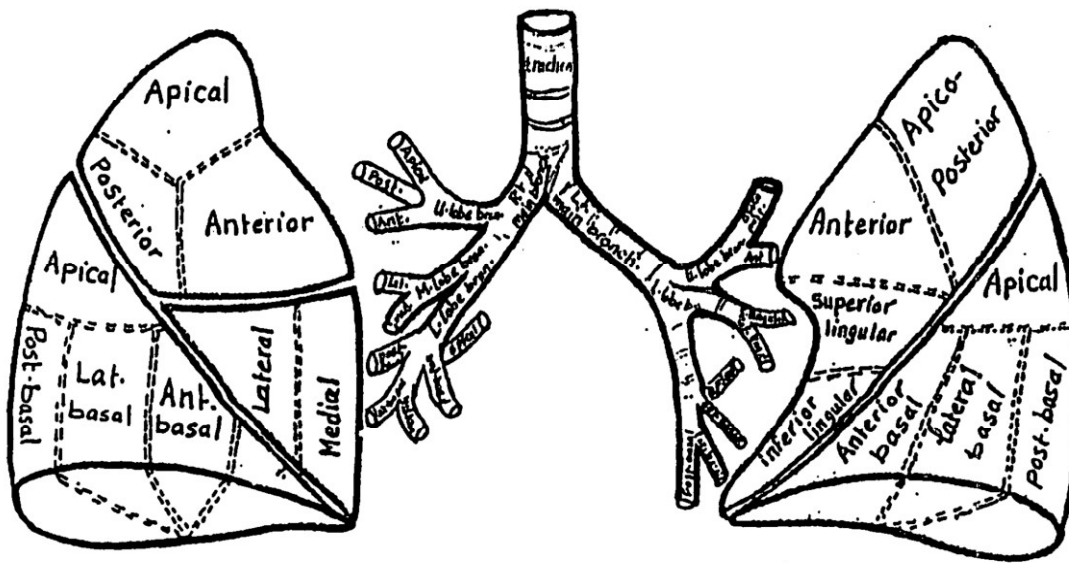


Relations of the Mediastinal Surfaces of lungs



	Mediastinal surface of the Rt. lung	Mediastinal Surface of the Lt. lung
(1) above the hilum	(a) immediately above the hilum there is a curved groove for the <u>arch of azygos v.</u> (b) above the level of the arch of azygos there are <u>3 vertical grooves</u> (from before backwards): (1) groove for Rt. innominate v. & phrenic n. (2) groove for the trachea & Rt. vagus n. (3) groove for the oesophagus.	(a) immediately above the hilum there is a broad arched groove for the <u>arch of aorta</u>. (b) above the level of the arch of aorta there are <u>3 vertical grooves</u> (from before backwards): (1) groove for Lt. C. carotid a. (2) groove for Lt. subclavian a. (3) groove for the oesophagus. <i>with Lt. phrenic n. & left vagus n. in between the 2 grooves.</i>
(2) in front of the hilum & pulmonary lig.	the mediastinal surface shows: (1) a wide concave <u>Cardiac impression</u> related to the <u>Rt. atrium & Rt. phrenic n.</u> (2) a groove for S.V.C. & Rt. phrenic n. joining the <u>upper part</u> of the Cardiac impression (in front of the hilum). (3) a groove for I.V.C. (& Rt. phrenic n.) joining the <u>lower part</u> of the Cardiac impression (in front of the pulm. ligament).	the mediastinal surface presents a wide deep concave <u>Cardiac impression</u> related to the left <u>ventricle (& Lt. phrenic n.)</u>.
(3) behind the hilum & pulm. lig.	there is a groove for the <u>oesophagus</u> & the <u>azygos v.</u> behind it.	there is a broad longitudinal groove for the <u>descending aorta</u> (and <u>oesophagus</u> in the lower part)

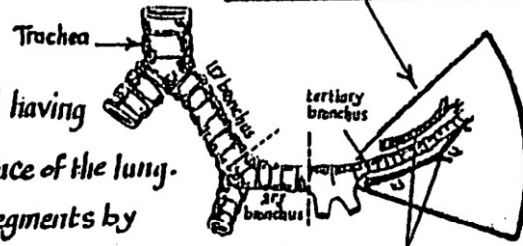
Broncho- Pulmonary Segments 30



* **Definition:** each lung is subdivided into functionally independent segments each of which is supplied by a tertiary bronchus & called bronchopulmonary segment.

* **Shape & structure:**

- each broncho-pulmonary segment is wedge shaped having an apex at the hilum of lung & a base at the surface of the lung.
- each segment is separated from the adjacent segments by fibrous septa & receives a branch from the pulmonary a. & a radicle of the pulmonary v.



* **Pattern & number of the broncho-pulmonary segments:** differs in both lungs:

Broncho pulmonary segments of Rt. lung (10)	Broncho pulmonary segments of Lt. lung (8)
(A) <u>the upper lobe</u> has 3 segments : (1) apical (2) posterior (3) anterior (B) <u>the middle lobe</u> has 2 segments : (4) lateral (5) medial (C) <u>the lower lobe</u> has 5 segments : (6) apical (7) ant. basal (8) post. basal (9) medial basal (10) lat. basal	(A) <u>the upper lobe</u> has 5 segments : (1) apical (2) posterior (3) anterior (4) Sup. lingual (5) inf. lingual (B) <u>the lower lobe</u> has 5 (or 4) segments : (6) apical (7) ant. basal (8) post. basal (9) lat. basal (10) med. basal (commonly absent or rudimentary) <u>N.B:</u> the Lt. lung is considered as consisting of 8 segments because the apical & posterior of the upper lobe have a common bronchus (apico-post. bio) & the medial basal segment of the lower lobe is frequently absent.

Differences between the Rt. & Lt. lungs **31**

	Right lung	Left lung
(1) Size	- slightly larger in size - wider - shorter due to the upward bulge of the Rt. cupola of the diaphragm.	- it is slightly smaller in size - narrower because the heart bulges more to the Lt. side
(2) Ant. border	- straight - has no lingula	presents a cardiac notch & projects below the notch forming the lingula.
(3) Fissures	2 : oblique & horizontal	only one fissure : the oblique.
(4) Lobes	3 : upper, middle & lower	only 2 : upper & lower
(5) Hilum	- has 2 bronchi : eparterial & hyparterial - has only one bronchial artery	- has only one main bronchus. - has 2 bronchial arteries
(6) Segments	has 10 broncho-pulmonary segments	has 8 broncho-pulmonary segments

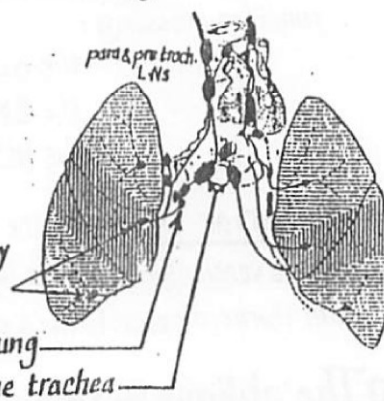
* Arterial supply of lungs:

- the Rt. lung is supplied by one bronchial a. (arising from the 3rd Rt. post. intercostal artery).
 - the Lt. lung : is supplied by 2 bronchial aa. arising from the descending thoracic aorta.
- N.B : the bronchial aa. supply oxygenated blood to the lung stroma & the bronchial tree.



* Venous drainage of lungs: 2 bronchial vv. drain each lung:

- the Rt. bronchial veins : open into the azygos v.
- the Lt. " " " " " " " " : open into the sup. hemiazygos v.



* Lymphatic drainage of lungs:

the interstitial lymphatics of the lung drain from the periphery towards the hilum passing through intrapulmonary lymph follicles to reach the broncho pulmonary L.Ns. at the hilum of the lung then to the tracheo-bronchial L.Ns. at the bifurcation of the trachea then they reach the pre & paratracheal L.Ns which are drained by the mediastinal lymph trunk.

* Nerve supply of lungs: is derived from the ant. & post. pulmonary plexus

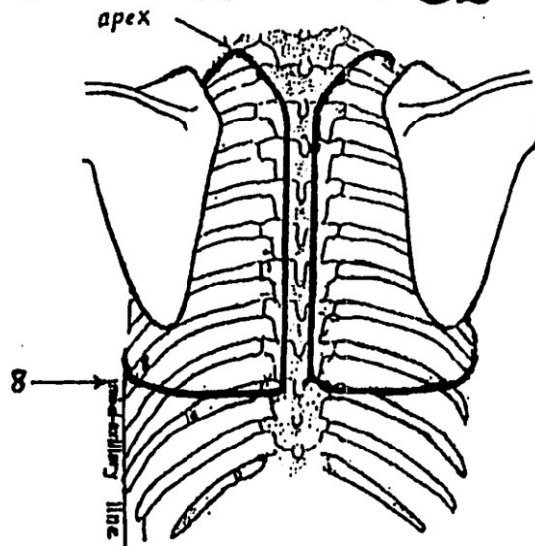
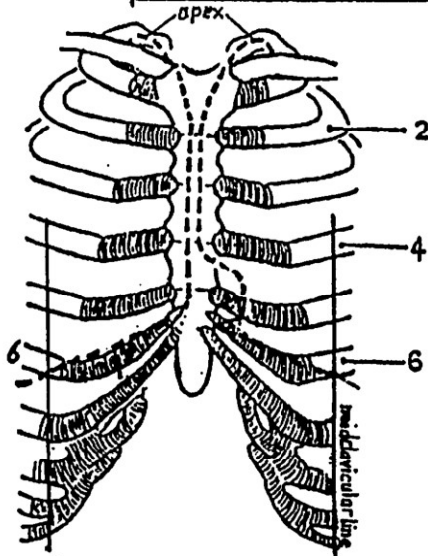
found at the roots of the lungs & formed of :

- (1) Sympathetic fibres (vaso constrictor & bronodilator) : from the 2nd, 3rd & 4th ganglia of the thoracic sympathetic chain.
- (2) parasymp. fibres : (vaso dilator & broncho constrictor) from the vagus n.

N.B : afferent impulses from the lung reach the C.N.s in both the symp. & parasymp. fibres



Surface anatomy of the lung 32



(1) **Apex of the lung**: the same as surface anatomy of the Cervical pleura.

(2) **the ant. border**:

- **of the Rt. lung**: Corresponds to the ant. border of the Rt. pleura (see page 25).
- **of the Lt. lung**: Corresponds to the ant. border of the Rt. pleura as far down as the level of the 4th costal cartilage then the ant. border of the Lt. lung separates from that of the left pleura & deviates $\frac{1}{2}$ an inch lat. to the lateral border of the sternum (forming the cardiac notch of the lung) then it curves downwards & medially to end at the 6th costochondral junction.

(3) **Lower border**: the same for the Rt. & the Lt. lungs:

it is represented by a curved line around the chest wall starting at the 6th sterno-costal junction crossing:

the 6th rib in the midclavicular line.

the 8th " " " midaxillary line.

the 10th thoracic spine posteriorly where the lower border ends.

(4) **Posterior border** (the same for the Rt. & Lt. lungs):

it runs vertically upwards alongside the vertebral column starting from the level of the 10th thoracic spine below & ending at the point of the apex above.

(5) **The oblique fissure**: draw a line passing obliquely downwards & outwards starting from a point 3 cm. lat. to the spine of the 3rd thoracic spine to the 6th costal cartilage 3 fingers from the median plane. (Another method of surface anatomy: see page 28).

(6) **The Horizontal fissure (of the Rt. lung)**:

draw a line starting from the ant. border of the Rt. lung at the 4th costal cartilage & running to the Rt. & slightly upwards to meet the oblique fissure in the midaxillary line.

* **CLINICALLY IMPORTANT POINTS RELATED TO LUNG**: see page 98.